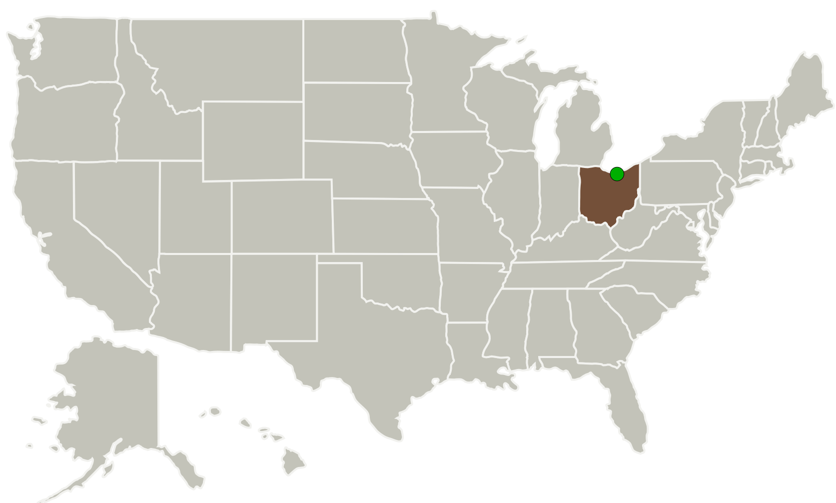
Design Concepts for Low Aspect Ratio High Pressure Turbines for High Bypass Ratio Turbofans, Phase I

Completed Technology Project (2016 - 2016)

Project Introduction

The proposal is to identify cycle improvements and verify structural feasibility of shrouding a low aspect ratio High Pressure Turbine(HPT) rotor designed to use ceramic blades. When the clearance-to-span ratio between the rotating blades and the stationary casing is the same as the clearance-to-span ratio between the rotating shroud and the stationary casing, stage efficiency improves. However, shrouding rotor blades increases centrifugal stresses, and metallic HPT rotor blades are typically unshrouded in order to maximize stage output. Ceramic Matrix Composite(CMC) blades weigh much less than metallic blades. Shrouded CMC blades have lower centrifugal stresses than unshrouded metallic blades. The fuel burn reduction from an increase in stage efficiency due to shrouded HPT blades will be determined. The fuel burn reduction due to the higher temperature capability of CMC blades will also be determined. Cycle efficiency improvements from shrouding HPT rotor blades will increase for future engines. The HPT blade aspect ratio will decrease as engine Overall Pressure Ratio(OPR) increases. Future HPT blade aspect ratios may be less than half of current aspect ratios. While the absolute clearance may decrease in future engines, the relative clearance is likely to increase. Aerothermal analyses will determine the improvement in fuel burn from shrouding cooled HPT rotor blades. Structural analyses will determine stresses for unshrouded metallic and CMC rotor blades, and for shrouded CMC blades.

Primary U.S. Work Locations and Key Partners



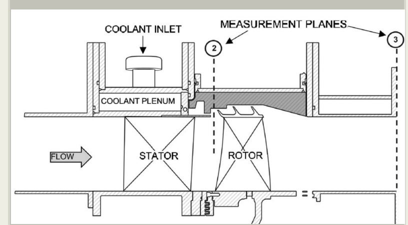


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Table of Contents

Design Concepts for Low Aspect Ratio High Pressure Turbines for High Bypass Ratio Turbofans, Phase I

Completed Technology Project (2016 - 2016)

Organizations Performing Work	Role	Type	Location
N&R Engineering	Lead Organization	Industry Small Disadvantaged Business (SDB)	Parma Heights, Ohio
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations
Ohio

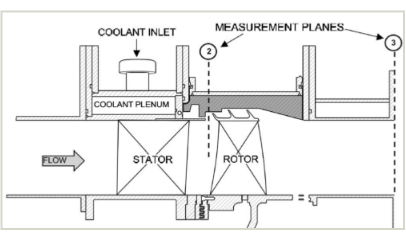
Project Transitions

June 2016: Project Start

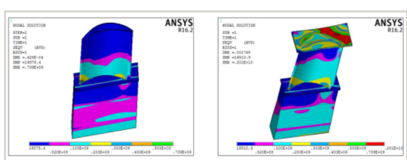
December 2016: Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/140067)*

Images



Briefing Chart Image
Design Concepts for Low Aspect Ratio High Pressure Turbines for High Bypass Ratio Turbofans, Phase I
(https://techport.nasa.gov/image/131937)



Final Summary Chart Image
Design Concepts for Low Aspect Ratio High Pressure Turbines for High Bypass Ratio Turbofans, Phase I Project Image
(https://techport.nasa.gov/image/130224)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

N&R Engineering

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

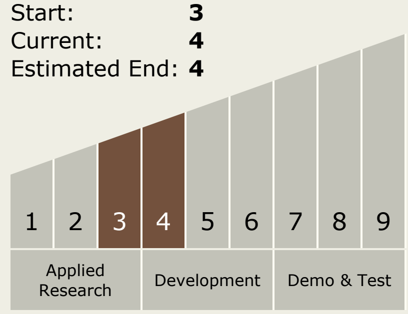
Carlos Torrez

Principal Investigator:

Robert J Boyle

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.3 Aero Propulsion
    └ TX01.3.4 Pressure Gain Combustion

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System